13.1.3 Alternative 3: Air Stripping with BACT Off-Gas Treatment and Municipal End Use

This alternative uses groundwater extraction wells placed at the leading edge of the plume. The extracted groundwater would be transmitted through buried piping to the air stripping treatment plant. Vapor-phase GAC, which is identified as a BACT for off-gas treatment, is considered in this alternative for detail analysis to treat the gas emission from the strippers. The treated groundwater would then be discharged into the municipal water supply system. Design criteria for this alternative are presented in Table 13-6.

Groundwater Extraction

The groundwater extraction process is the same as in Alternative 2 and consists of four 1,750 gpm wells located at the leading edge of the plume. The water collection and transmission and treatment plant sites are the same as Alternative 2.

Treatment System

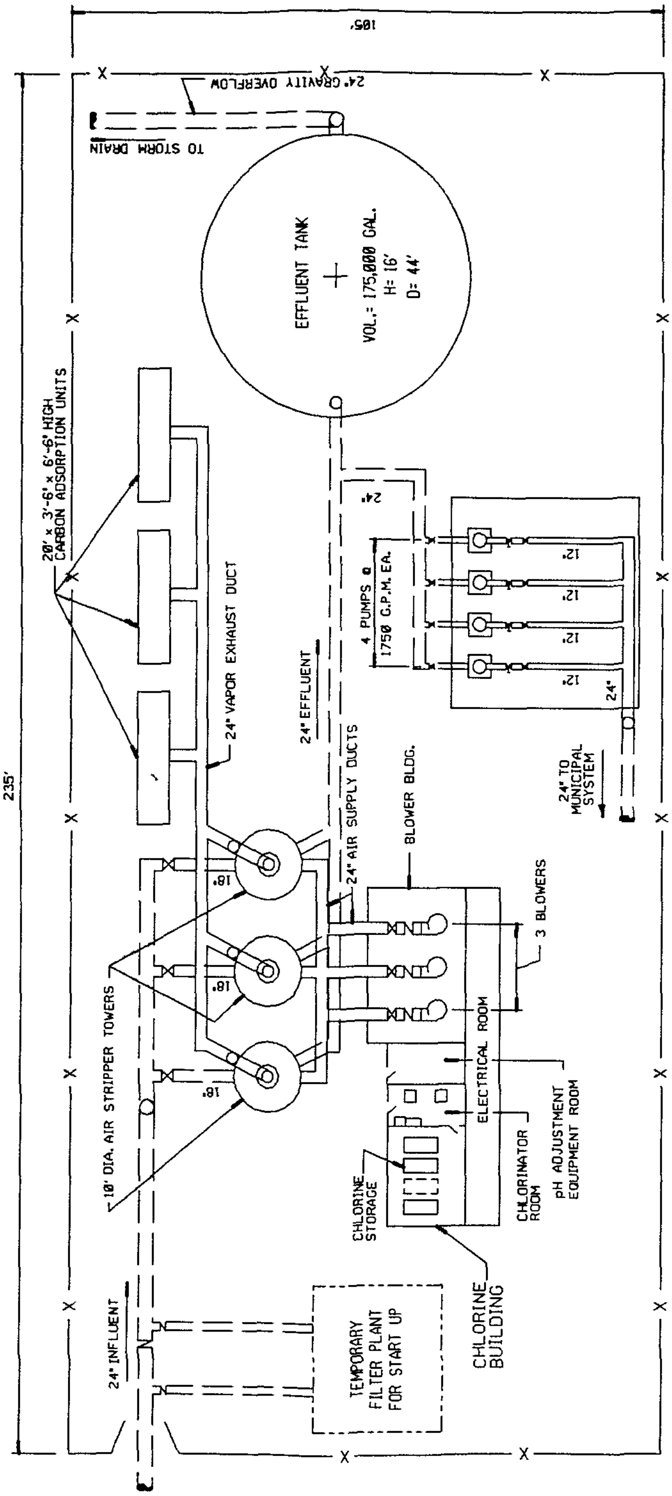
The proposed layout of the treatment plant is shown on Figure 13-3.

Air Stripping with Off-gas Treatment. The treatment process consists of air stripping towers operating in parallel to treat the total plant flow. For specific plant design information refer to Table 13-6. The operation would be the same for each tower. The air stripping process employs countercurrent flows of air and water in a vertical packed tower. The tower is filled with packing material that enhances the contact of the water with the air. Water from the extraction wells is pumped directly to the top of the tower where an orifice hole type distribution tray assures even distribution of the water across the tower packing and prevents channeling. Raw water cascades downward through the tower packing as the air passes upward through the packing. The water is collected in a sump at the bottom of the tower and pumped into the effluent tank. Air for the towers is supplied from centrifugal type fan blowers located within the same room, adjacent to the towers. Air is conveyed to the bottom of the towers through above ground ducting.

Air flow is directed through a mist eliminator to separate water vapors before exiting the air stripper. The mist eliminator is installed at the top of the tower. An exhaust duct directs the air flow from the top of the tower to the carbon adsorption units. The exhaust system contains an electric air heater/dryer through which the air passes on its way to the carbon adsorption units. The carbon units remove the organic compounds before discharging the air to the atmosphere. The carbon units are also designed to operate in parallel with adequate reserve capacity to allow one unit to be taken off line and still treat all of the vapor from the air stripping towers. There may be an alternate BACT such as resin adsorption which may be evaluated during the RD phase. This report uses vapor phase GAC (see Subsection 12.3.3) as the BACT for cost estimation purposes since it is known to meet SCAQMD requirements for emissions controls.

Effluent System. The effluent system operates the same as for Alternative 2. Water from the tower sump discharges into a common header that conveys the water to the effluent tank. The effluent tank serves as a clearwell and forebay for the booster pumps.

Disinfection. The disinfection system operates the same as for Alternative 2. Water discharged from the tower sump would be chlorinated to provide a residual for the municipal water system.



URS Consultants, Inc. Sacramento, Ca	MUSCOY PLUME OU RI/FS REPORT NEWMARK GROUNDWATER CONTAMINATION SUPERFUND SITE	FIGURE 13-3 ALTERNATIVE 3 AIR STRIPPING WITH BACT (OR VAPOR PHASE GAC) OFF-GAS TREATMENT AND MUNICIPAL END USE

pH Control System. A pH control system is provided to control pH of water entering the air stripping tower. This helps to prevent biological growth and scaling on packing materials and also to prevent degradation of packing materials due to acidic or basic water. The system would consist of feed pump, tank, and automatic control. The system would be housed in its own building.

Start-Up Filtration. The operation of the pre-filtration plant would be the same as Alternative 2. The bag filters would operate during plant start-up and well development.

End Use

The end use of the treated water is the same as Alternative 2. Water would be supplied for municipal use.

Groundwater Monitoring Wells

The groundwater monitoring wells in this alternative are the same as those discussed in Alternative 2. Four monitoring wells would be installed in the vicinity of the proposed extraction wells. The depth of these wells would be 1,200 feet.

Overall Protection of Human Health and the Environment - The air stripping with BACT (or vapor-phase GAC) off-gas treatment and municipal end use alternative would protect human health and the environment.

This alternative is a treatment control which transfers contaminants from groundwater to the vapor phase in the air stripper, and from vapor phase to vapor phase carbon by adsorption in carbon vessels. Off-site regeneration serves to destroy contaminants in the same process as aqueous-phase carbon, which eliminates risks posed to human health and the environment. On-site regeneration can be used but this would require evaluation of air quality standards and boiler offsets would likely be required. On-site regeneration should be considered during RD.

Using the municipal supply for end use increases protection by reducing contamination levels to drinking water standards after the associated treatment.

Compliance with ARARs - Alternative 3 does comply with the ARARs identified in the ARARs analysis (Section 8.0), including treatment of contaminated water to MCLs and emissions controls with BACT. Although off-site activities are not evaluated as ARARs, all applicable requirements for off-site actions would be observed.

Long-Term Effectiveness and Permanence - The air stripping with BACT (or vapor-phase GAC) off-gas treatment and municipal end use alternative would provide long-term effectiveness.

As discussed in the evaluation of Alternative 2, the magnitude of residual risk is low, and the alternative would be adequate and suitable to treat the volume of groundwater expected to be encountered within Muscoy Plume OU. It is a proven and reliable method for treating groundwater that would not result in untreated wastes remaining on-site except VOCs adsorbed to organic carbon in the soil.

Reduction of Toxicity, Mobility, or Volume - This alternative would permanently and irreversibly reduce contaminant toxicity, mobility, and volume through air stripping, carbon adsorption and carbon regeneration. It is expected to reduce levels of contamination to meet RA objectives, and also to meet air contaminant discharge requirements.

Short-Term Effectiveness - The air stripping with BACT (or vapor-phase GAC) off-gas treatment and municipal end-use alternative would provide short-term effectiveness.

Similar to the discussion of Alternative 2, there are not expected to be potential health threats to area residents or the environment during the construction and implementation phases of this alternative. Personnel responsible for handling spent carbon would need to have proper personal protective equipment. This alternative differs from aqueous-phase GAC in that vapor phase carbon is changed in a dry state. Dust control and air monitoring in work areas would be required.

Implementability - The air stripping with BACT (or vapor phase GAC) off-gas treatment and municipal end use alternative would be implementable.

Similar to the discussion for Alternative 2, the technologies are demonstrated and commercially available, and significant technical unknowns are not expected during construction and operation.

This alternative is considered to be reliable to operate and maintain during implementation, and additional remedial actions are not expected to be difficult to implement. Regular monitoring of the air stripper and vapor phase GAC systems would be required to maintain consistent operation. Other monitoring would be considered to be easily accomplished at the extraction well and regeneration facility.

Administrative feasibility would be similar to that of Alternative 2, with permits for on-site treatment, off-site spent carbon transport, and approval for treated water disposal into the municipal supply being required and expected to be appropriately obtained. This alternative would also require an air discharge permit that was not required in Alternative 2.

Availability of regeneration facilities, necessary equipment, and personnel is also expected to be high.

Cost - Table 13-7 presents the costs associated with this alternative. The costs for Alternative 3 are: capital cost - approximately $7.0 million, annual O&M cost - approximately $0.9 million, and total present worth - approximately $21.5 million.

13.1.4 Alternative 4: Advanced Oxidation (Ozone/Peroxide) with Municipal End Use

This alternative uses groundwater extraction wells placed at the leading edge of the plume. The extracted groundwater would be transmitted through buried piping to an advanced oxidation treatment plant. The treated groundwater would then be discharged into the municipal water supply system.

Groundwater Extraction

The groundwater extraction process is the same as in Alternative 2 and consists of four 1,750 gpm extraction wells at the leading edge of the plume. Water collection, transmission systems, and the proposed treatment plant site are also the same as Alternative 2.

Table 13-7

ESTIMATED COST - ALTERNATIVE 3: AIR STRIPPERS WITH BACT OFF-GAS TREATMENT AND MUNICIPAL END USE

Description	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Total	Total Cost Material	Total Cost Labor	Total
CAPITAL COST								
Groundwater Extraction								
Extraction Wells	4,000	lf	$70	$180	$250	$280,000	$720,000	$1,000,000
Extraction Pumps	4	ea	20,000	4,000	24,000	80,000	16,000	96,000
Pipeline	10,080	lf	50	58	108	504,000	584,640	1,088,640
Subtotal								$2,184,640
Treatment Facilities								
Start-up Filters	2	ea	$33,000	$5,000	$38,000	$66,000	$10,000	$76,000
Strippers,Controls,Blowers	3	ea	138,000	50,000	188,000	414,000	150,000	564,000
Air Heater	3	ea	7,650	800	8,450	22,950	2,400	25,350
GAC Units (Vapor)	3	ea	60,000	6,000	66,000	180,000	18,000	198,000
Effluent Tank	1	ea	60,000	30,000	90,000	60,000	30,000	90,000
Chlorination System	1	ls	25,000	6,000	31,000	25,000	6,000	31,000
pH Control System	1	ls	10,000	7,000	17,000	10,000	7,000	17,000
Building	1,250	sf	50	20	70	62,500	25,000	87,500
Structural	1	ls			80,000			80,000
Site Work & Yard Piping		ls			160,000			160,000
Site Electrical		ls			200,000			200,000
Subtotal								$1,528,850

Table 13-7 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 3: AIR STRIPPERS WITH BACT OFF-GAS TREATMENT AND MUNICIPAL END USE

Description	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Total	Total Cost Material	Total Cost Labor	Total Cost Total
CAPITAL COST (Cont'd.)								
End Use								
Booster Pumps	4	ea	$15,000	$2,000	$17,000	$60,000	$8,000	$68,000
Subtotal								$68,000
Groundwater Monitoring Wells								
Wells	4,800	lf	$50	$105	$155	$240,000	$504,000	$744,000
Subtotal								$744,000
TOTAL CONSTRUCTION COST								$4,525,490
Contractor OH & P		15%						$678,824
Engineering & Const. Management		15%						678,824
Administration		5%						226,275
Contingency		20%						905,098
TOTAL CAPITAL COST								$7,014,511

Table 13-7 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 3: AIR STRIPPERS WITH BACT OFF-GAS TREATMENT AND MUNICIPAL END USE

Description	Utilities	Materials	Labor	Total
ANNUAL O&M COST				
Groundwater Extraction				
Extraction Wells	$238,270	$20,000	$16,000	$274,270
Pipeline	0	10,000	5,000	15,000
Subtotal				$289,270
Treatment Facilities				
Strippers,Controls,Blowers	$10,600	$37,000	$50,000	$97,600
Air Heater	105,120	1,300	500	106,920
GAC Units		120,000	2,400	122,400
Chlorination System	650	6,200	7,200	14,050
pH System	650	2,000	7,200	9,850
Subtotal				$350,820
End Use				
Booster Pumps	$210,240	$16,000	$8,000	$234,240
Subtotal				$234,240
Groundwater Monitoring				
Monitoring Wells	$0	$33,600	$35,200	$68,800
Subtotal				$68,800
TOTAL ANNUAL O&M COST				$943,130
PRESENT WORTH OF ANNUAL O&M COST				$14,498,220
TOTAL PRESENT WORTH				$21,512,731

Treatment System

The proposed layout of the treatment plant is shown on Figure 13-4.

Advanced Oxidation Treatment. The treatment process would be arranged to treat and dose individual 1,000 gpm flow streams in parallel. Table 13-8 presents specific plant information. Individual 1,000 gpm streams were selected because of existing experience in treating PCE at this flow rate. The operation is the same for each treatment stream. Each stream uses three, 5,000-gallon concrete primary reaction tanks (Reactor Tanks 1, 2 and 3) operating in series. Hydrogen peroxide is injected into the header ahead of Tank 1 and ozone is injected into all three primary tanks. Preliminary oxidation of organics occurs in the primary tanks.

The secondary oxidation reactor tank is contained within a building and is used for removing ozone and peroxide from the water as well as a final polish for the removal of organic residuals. The secondary tanks are 3,900 gallons (each). Stainless steel reactors also contain ultraviolet light (UV) lamps. These reactors serve as UV photolysis polishers.

Off gas from the secondary tank is treated by a standard catalytic ozone decomposer to remove any residual ozone and TCE or PCE vapors present in the vapor stream. The TCE and PCE are oxidized to Cl^-, CO_2, and H_2O. The ozone is decomposed to oxygen. System operation is monitored and shut-down functions are automated in the case of either the water flow stopping, overheating of the electrical enclosures, or an interruption of the chemical feed systems.

Two ozone generators were selected to supply two percent by weight ozone to both the primary and secondary tanks. One generator will normally supply the required ozone dosage. The second generator will function as a backup unit. Two air preparation units consisting of an air compressor, heatless absorption dryers, filters and coalesces are also a part of the system. Like the ozone generator system, one will operate normally to supply air to the generators and the second will function as a backup unit.

The peroxide feed system consists of two standard chemical feed pumps. One pump would normally be operating and one would be provided for backup. Peroxide would be withdrawn from a tank on the site sized to provide storage capacity in excess of the normal 30 day requirement.

The advanced oxidation technology has been demonstrated in the EPA's Superfund Innovative Technology Evaluation (SITE) program to be capable of oxidizing PCE, TCE, and cis-1,2-DCE. The experience is however limited to smaller flow rates (200 gpm). Operation of this alternative in the Muscoy Plume OU would require both bench and pilot scale programs prior to commitment to full scale design.

Effluent System. The effluent system operates the same as for Alternative 2. Water from the secondary tanks discharges into a common header that conveys the water to the effluent tank. The effluent tank serves as a clearwell and forebay for the booster pumps.

Disinfection. The disinfection system operates the same as for Alternative 2. However, since ozone and peroxide have been added to the water as a part of the treatment process, the chlorine dosage rate would be somewhat less than for the other alternatives.

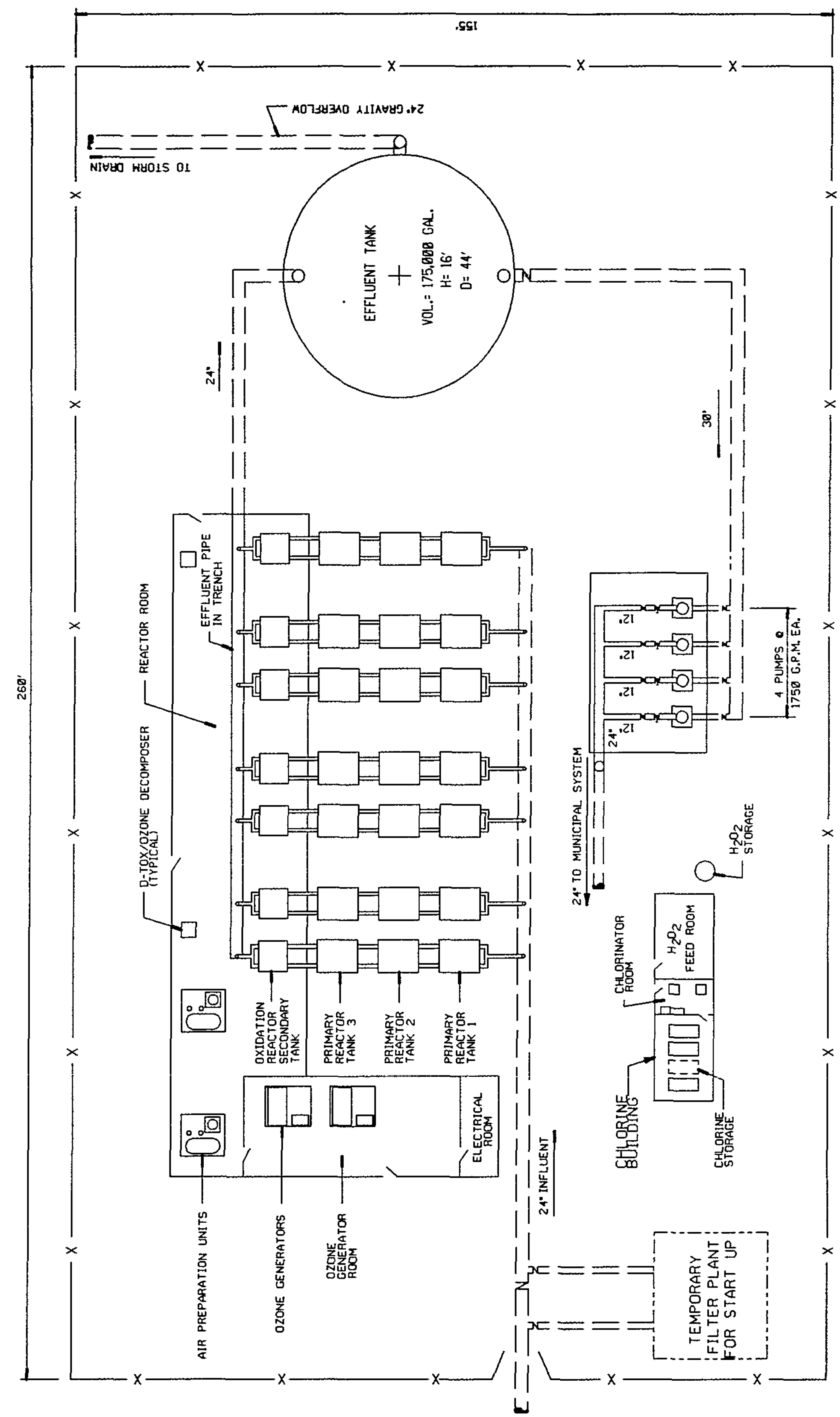


FIGURE 13-4

ALTERNATIVE 4
ADVANCED OXIDATION (OZONE/PEROXIDE)
AND MUNICIPAL END USE

URS Consultants, Inc. Sacramento, Ca	MUSCOY PLUME OU RI/FS REPORT NEWMARK GROUNDWATER CONTAMINATION SUPERFUND SITE

Table 13-8

DESIGN CRITERIA
ALTERNATIVE 4

Item	Units	Quantity
GROUNDWATER EXTRACTION SYSTEM		
1. Extraction Wells		
Number	each	4
Capacity (each)	gpm	1,750
Total Capacity	gpm	7,000
Estimated Well Depth	ft	1,000
Approximate Depth to Groundwater	ft	150
Casing Diameter	inch	20
Approximate Pumping Head (each)	ft	200
Extraction Pump Rating (each)	hp	90
2. Raw Water Transmission System		
24-inch Diameter	lf	2,680
18-inch Diameter	lf	3,800
16-inch Diameter	lf	3,600
TREATMENT SYSTEM		
1. Plant Capacity	gpm	7,000
	MGD	10.1
Influent Concentration		
Tetrachloroethene (PCE)	$\mu g/\ell$	30
Trichloroethene (TCE)	$\mu g/\ell$	10
cis-1,2-Dichloroethene (cis-1,2-DCE)	$\mu g/\ell$	10
Effluent Concentration		
Tetrachloroethene (PCE)	$\mu g/\ell$	2.5
Trichloroethene (TCE)	$\mu g/\ell$	2.5
cis-1,2-Dichloroethene (cis-1,2-DCE)	$\mu g/\ell$	3.0

Table 13-8 (Cont'd.)

DESIGN CRITERIA
ALTERNATIVE 4

Item	Units	Quantity
2. Treatment		
Type: Advanced Oxidation (Ozone/Peroxide)		
Number of Treatment Streams	each	7
Operation	--	parallel
Flow Rate (each stream)	gpm	1,000
Flow Rate (one stream offline)	gpm	1,167
Primary Tank Capacity (Tanks 1, 2 and 3 in each stream)	gal	15,000
Secondary Tank Capacity	gal	3,900
Total Retention Time	min	6.4
Actual Contact Retention (in Secondary UV Tank)	min	3
Ozone System		
Design Dosage Rate	mg/L	10.5
	lb/day	883
Ozone Generator		
Number of Units (with 1 backup)	each	2
Generation Capacity (each - 2% air)	lb/day	600
Total Generating Capacity (2% air)	lb/day	1,200
Air Preparation Unit		
Number of Units (with 1 backup)	each	2
Hydrogen Peroxide System		
Design Dosage	mg/L	4.5
	lb/day	378
Dosage (100% solution)	gal/hr	1.72
30-Day Supply	gal	1,240
Number of Units	each	1
H_2O_2 Pumps (with 1 backup)	each	2
H_2O_2 Pump Capacity (each)	gal/hr	2-3
Vapor Treatment System		
Number of Units (with 1 backup)	each	2
3. Effluent Tank		
Working Capacity	gal (1,000)	175
Size (Diameter x Height)	ft	44 x 16
Seismic Construction	--	anchored

Table 13-8 (Cont'd.)

**DESIGN CRITERIA
ALTERNATIVE 4**

Item		Units	Quantity
4.	Disinfection		
	Type: Gaseous Chlorine		
	Dosage Rate	mg/L	0.5 - 1.0
		lb/day	42 - 84
	Residual	mg/L	0.3 - 0.5
	Unit Size	lb/day	200
	Control	--	continuous
	Storage Cylinder Size	lb	2,000
	Number of Cylinders	each	4
	Feed Pump	each	1
	Feed Pump Rating	hp	1
5.	Start Up Filtration		
	Type: Bag Filters		
	Number of Units	each	2
	Number of Bags (per unit)	each	46
	Flow per Unit	gpm	3,500
	Flow per Bag	gpm	150
FINAL USE			
1.	Municipal System		
	Pumps: Vertical		
	Number	each	4
	Total Pumping Rate	gpm	7,000
	Pumping Rate (each)	gpm	1,750
	Approximate Pumping Head (each)	ft	175
	Pump Rating (each)	hp	80

Start-Up Filtration. The operation of the pre-filtration plant would be the same as Alternative 2. The bag filters would operate during plant start-up and well development.

End Use

The end use of the water is the same as Alternative 2. Water would be supplied to the municipal end use.

Groundwater Monitoring Wells

The groundwater monitoring wells in this alternative are the same as those discussed in Alternative 2. Four monitoring wells would be installed in the vicinity of the proposed extraction wells. The depth of these wells is 1,200 feet.

Overall Protection of Human Health and the Environment - The advanced oxidation with municipal end-use alternative would protect human health and the environment.

This alternative eliminates contaminants from groundwater by destruction during the oxidation process. Similar to Alternatives 2 and 3, this alternative would eliminate the risks posed to human health and the environment. Municipal supply end use would increase protection by reducing contamination levels to drinking water standards.

Compliance with ARARs - Alternative 4 does comply with the ARARs identified in the ARARs analysis (Subsection 8.1), including treatment of contaminated water to MCLs. Although off-site activities are not evaluated as ARARs, all applicable requirements for off-site actions would be observed.

Long-term Effectiveness and Permanence - This alternative is expected to provide a high degree of long-term effectiveness and permanence, similar to Alternatives 2 and 3.

If implemented, the magnitude of residual risk is expected to be low because groundwater contaminants are extracted and destroyed. Upon completion of the remedial action, the only subsurface residual contamination remaining would be that adsorbed to organic carbon contained in the soil at the site. The adequacy and reliability of advanced oxidation is undemonstrated for municipal end use since there is a lack of long-term operational data. This may result in the requirement of a GAC contingency treatment process to assure effluent water quality. The system could require replacement with a demonstrated system if operating costs became too high.

Reduction of Toxicity, Mobility, or Volume - The advanced oxidation with municipal end-use alternative would provide appropriate reduction of contaminant toxicity, mobility, and volume.

This alternative permanently and irreversibly reduces contaminant toxicity, mobility, and volume through oxidation. Similar to Alternatives 2 and 3, this alternative is expected to reduce levels of contamination to meet RA objectives. It is unlikely that treatment would reverse or that residuals would result from the treatment.

Short-Term Effectiveness - The advanced oxidation with municipal end-use alternative would provide short-term effectiveness.

Similar to the discussion of Alternatives 2 and 3, significant health threats to area residents or the environment would not be expected during construction and implementation of this alternative. Oxidant handling and ozone generation would increase risks that are not present with either Alternatives 2 and 3, but advanced oxidation does not require carbon regeneration. Personnel responsible for oxidant handling would need to be properly protected (via personal protection equipment) against dermal contact and inhalation.

Implementability - Technically, advanced oxidation is an innovative remedial approach that is undemonstrated for the expected flow rates at Muscoy Plume OU. Similar systems (such as the City of Southgate plant with a flow capacity of 1,200 gpm) are operating and suggest that advanced oxidation can be implemented.

During construction and operation, significant technical unknowns are not expected, other than standard details associated with a large construction project.

The alternative would require specialized personnel trained to operate and maintain the system during implementation. Additional RA is not expected to be difficult to implement, and monitoring the alternative is considered to be easily accomplished at the extraction wells and oxidation unit.

Availability of necessary equipment and personnel is expected to be high.

Cost - Table 13-9 presents the costs associated with this alternative. The project costs for Alternative 4 are: capital cost - approximately $12.5 million, annual O&M cost - approximately $1.3 million and total present worth - approximately $32.0 million. The cost does not include use of a GAC system as a contingency for the advanced oxidation system. The actual cost for the GAC contingency may not be known until a treatability study is performed to evaluate the effectiveness of the advanced oxidation system. Nevertheless, the present worth cost may be much higher than $32.0 million if a GAC contingency system is required.

13.1.5 Alternative 5: Aqueous GAC with Reinjection

This alternative uses groundwater extraction wells placed ahead of the leading edge of the plume. The extracted groundwater would be transmitted through buried piping to the GAC treatment plant. The treated water would then be reinjected into the groundwater aquifer using 8 injection wells. The location of the injection wells are shown in Figure 13-1. Design criteria for this alternative are presented in Table 13-10.

Groundwater Extraction

The groundwater extraction process is the same as in Alternative 2 and consists of four 1,750 gpm wells at the leading edge of the plume. The water collection and transmission system and the proposed treatment plant sites are also the same as Alternative 2.

Treatment System

The proposed South Treatment Plant is shown on Figure 13-5.

Table 13-9

ESTIMATED COST - ALTERNATIVE 4: ADVANCED OXIDATION SYSTEM WITH MUNICIPAL END USE

Description	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Total	Total Cost Material	Total Cost Labor	Total Cost Total
CAPITAL COST								
Groundwater Extraction								
Extraction Wells	4,000	lf	$70	$180	$250	$280,000	$720,000	$1,000,000
Extraction Pumps	4	ea	20,000	4,000	24,000	80,000	16,000	96,000
Pipeline	10,080	lf	50	58	108	540,000	584,640	1,088,640
Subtotal								2,184,640
Treatment Facilities								
Start-up Filters	2	ea	$33,000	$5,000	$38,000	$66,000	$10,000	$76,000
Oxidation System & Controls	1	ls	3,510,000	366,000	3,876,000	3,510,000	366,000	3,876,000
Effluent Tank	1	ls	60,000	30,000	90,000	60,000	30,000	90,000
Chlorination System	1	ls	25,000	6,000	31,000	25,000	6,000	31,000
Building	5,250	sf	50	20	70	262,500	105,000	367,500
Structural	1	ls			80,000			80,000
Site Work & Yard Piping		ls			200,000			200,000
Site Electrical		ls			330,000			330,000
Subtotal								$5,050,500

Table 13-9 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 4: ADVANCED OXIDATION SYSTEM WITH MUNICIPAL END USE

Description	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Total	Total Cost Material	Total Cost Labor	Total Cost Total
CAPITAL COST (Cont'd.)								
End Use								
Booster Pumps	4	ea	$15,000	$2,000	$17,000	$60,000	$8,000	$68,000
Subtotal								$68,000
Groundwater Monitoring Wells								
Wells	4,800	ea	$50	$105	$155	$240,000	$504,000	$744,000
Subtotal								$744,000
TOTAL CONSTRUCTION COST								$8,047,140
Contractor OH & P		15%						$1,207,071
Engineering & Const. Management		15%						1,207,071
Administration		5%						402,357
Contingency		20%						1,609,428
TOTAL CAPITAL COST								$12,473,067

Table 13-9 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 4: ADVANCED OXIDATION SYSTEM WITH MUNICIPAL END USE

Description	Utilities	Materials	Labor	Total
ANNUAL O&M COST				
Groundwater Extraction				
Extraction Wells	$238,270	$20,000	$16,000	$274,270
Pipeline	0	10,000	5,000	15,000
Subtotal				$289,270
Treatment Facilities				
Oxidation System	$537,400	$103,330	$23,200	$663,930
Chlorination System	650	6,200	7,200	14,050
Subtotal				$677,980
End Use				
Booster Pumps	$210,240	$16,000	$8,000	$234,240
Subtotal				$234,240
Groundwater Monitoring				
Monitoring Wells	0	$33,600	$35,200	$68,800
Subtotal				$68,800
TOTAL ANNUAL O&M COST				$1,270,290
PRESENT WORTH OF ANNUAL O&M COST				$19,527,471
TOTAL PRESENT WORTH				$32,000,538

Table 13-10

DESIGN CRITERIA
ALTERNATIVE 5

Item	Units	Quantity
GROUNDWATER EXTRACTION SYSTEM		
1. Extraction Wells		
Number	each	4
Capacity (each)	gpm	1,750
Total Capacity	gpm	7,000
Estimated Well Depth	ft	1,000
Approximate Depth to Groundwater	ft	150
Casing Diameter	inch	20
Approximate Pumping Head (each)	ft	200
Extraction Pump Rating (each)	hp	90
2. Raw Water Transmission System		
24-inch Diameter	lf	2,680
18-inch Diameter	lf	3,800
16-inch Diameter	lf	3,600
TREATMENT SYSTEM		
1. Plant Capacity	gpm	7,000
	MGD	10.1
Influent Concentration		
Tetrachloroethylene (PCE)	$\mu g/\ell$	30
Trichloroethylene (TCE)	$\mu g/\ell$	10
cis-1,2-Dichloroethene (cis-1,2-DCE)	$\mu g/\ell$	10
Effluent Concentration		
Tetrachloroethylene (PCE)	$\mu g/\ell$	0.5
Trichloroethylene (TCE)	$\mu g/\ell$	0.5
cis-1,2-Dichloroethene (cis-1,2-DCE)	$\mu g/\ell$	0.5

Table 13-10 (Cont'd.)

DESIGN CRITERIA
ALTERNATIVE 5

Item	Units	Quantity
2. Treatment		
Type: Granular Activated Carbon		
Number of Units	pairs	10
Unit Operation	--	series
Plant Operation		parallel
Flow Per Unit	gpm	700
Total Number of Vessels	each	20
Empty Bed Contact Time (EBCT)(each vessel)	min	7.5
EBCT (per pair)	min	15
Carbon Volume (each)	ft^3	715
Carbon Volume (each pair)	ft^3	1,430
Carbon Weight (per vessel)	lb	20,000
Carbon Weight (per pair)	lb	40,000
Total Plant Carbon	lb	400,000
Estimated Carbon Life (per vessel)	days	133
Estimated Annual Usage	lb	550,000
3. Effluent Tank		
Working Capacity	gal (1000)	175
Size (Diameter x Height)	ft	44 x 16
Seismic Construction	--	anchored
4. Backwash System		
Rate	gpm	1,000
Nominal Time	min	20
Tank Size (Diameter x Height)	ft	26 x 8
Tank Working Capacity	gal (1000)	28
Tank Seismic Construction	--	anchored
Number of Backwash Pumps (each)	each	1
Backwash Pump Rating	hp	15
5. Start Up Filtration		
Type: Bag Filters		
Number of Units	each	2
Number of Bags (per unit)	each	46
Flow per Unit	gpm	3,500
Flow per Bag	gpm	150
6. pH Control		
Number of Units	each	1
Approximate Influent pH	--	7.1 - 7.4
Approximate Effluent pH	--	7
Feed Pump	each	1
Feed Pump Rating	hp	1

Table 13-10 (Cont'd.)

DESIGN CRITERIA
ALTERNATIVE 5

Item	Units	Quantity
END USE		
1. Injection Wells		
Number	each	8
Capacity (each)	gpm	875
Total Capacity	gpm	7,000
Estimated Well Depth		
4 wells (each)	ft	1,000
4 wells (each)	ft	700
Approximate Depth to Groundwater	ft	150
Casing Diameter	inch	20
2. Finished Water Transmission System		
18-inch Diameter	ft	8,700
18-inch Diameter (in influent pipe trench)	ft	10,000
16-inch Diameter	ft	6,700
10-inch Diameter	ft	4,800
3. Booster Pumps		
Number of Pumps: Vertical	each	4
Total Pumping Rate	gpm	7,000
Pumping Rate (each	gpm	1,750
Approximate Pumping Head (each)	ft	70
Pump Rating (each)	hp	30

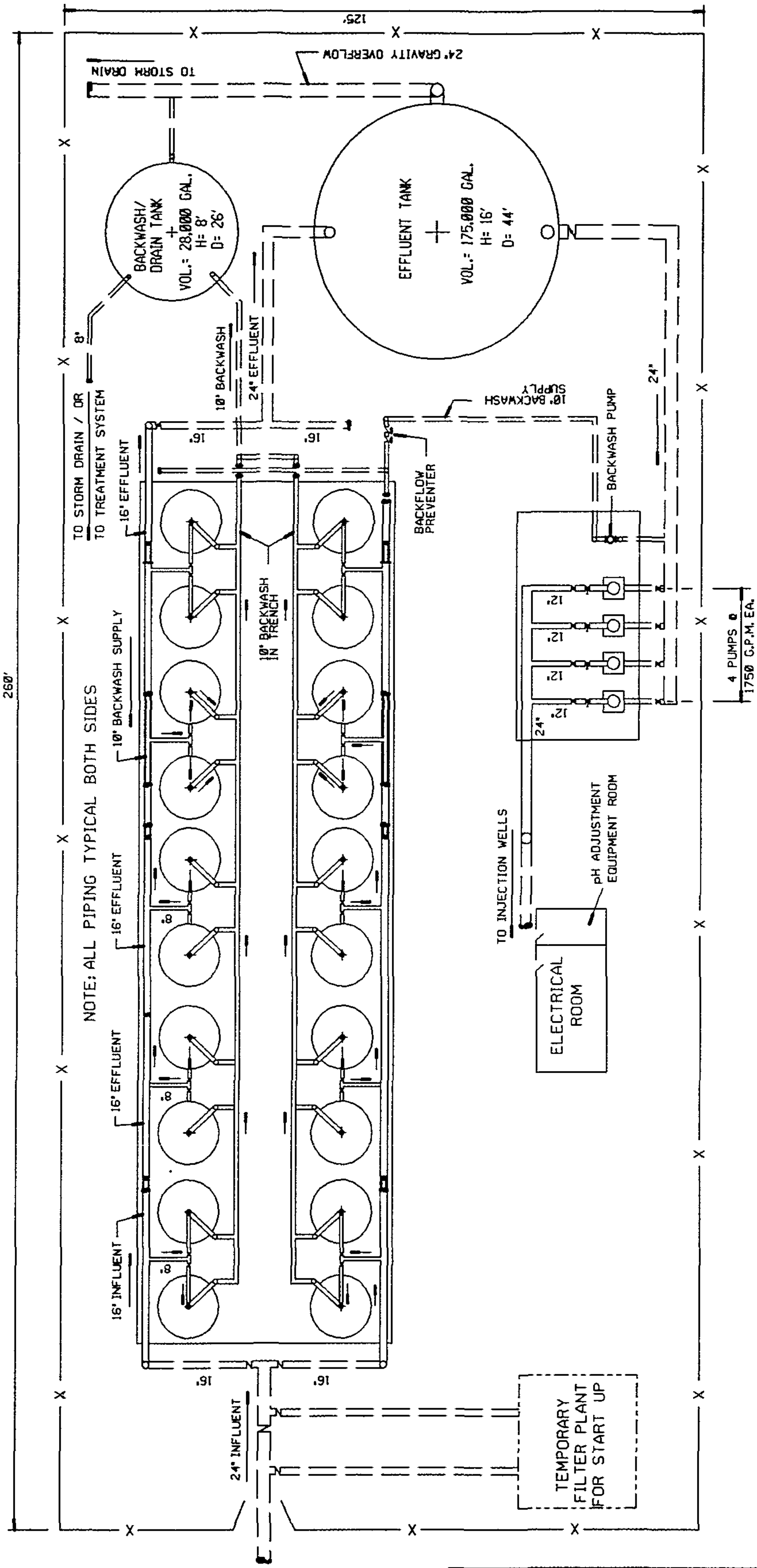


FIGURE 13-5

ALTERNATIVE 5
AQUEOUS GAC WITH REINJECTION

URS Consultants, Inc. Sacramento, Ca	MUSCOY PLUME OU RI/FS REPORT NEWMARK GROUNDWATER CONTAMINATION SUPERFUND SITE

GAC Treatment. The GAC treatment process is the same as for Alternative 2. Raw water is treated by pairs of GAC units. Each pair operates in series with a lead and a lag treatment vessel. The plant is composed of multiple pairs operating in parallel. Other GAC configurations could be used successfully. The final system design will be chosen during RD.

Effluent System. The effluent system operates the same as for Alternative 2. Treated water from the lag vessel discharges into a common header that conveys the water to the effluent tank. The effluent tank serves as a clear well and forebay for the booster pumps. The four booster pumps, each pumping at 1,750 gpm, discharge water through effluent pipeline to the injection wells.

pH Control System. This system operates the same as for Alternative 3, but in this alternative, pH of the effluent water from the GAC is controlled using the pH control system.

Backwash System. The backwash system for this alternative is the same as for Alternative 2. The GAC vessels backwash using piping and valving contained within the skid mounted units. Wash water flows to the backwash holding tank where it is discharged to the storm drain or recycled to the treatment system.

Start-Up Filtration. The operation of the pre-filtration plant will be the same as Alternative 2. The bag filters will operate during plant start-up and well development.

End Use

This alternative would re-inject the treated water from the treatment plant back into the groundwater aquifer. Eight injection wells, with a total capacity of 7,000 gpm would be located along the western and eastern boundary of the plume as shown on Figure 13-1. Each of the four injection wells located along the eastern and western boundary of the plume would be drilled to an approximate depth of 700 feet and 1,000 feet, respectively. The injection wells would be used solely for the purpose of disposal. Water would be conveyed to the injection wells via a transmission pipeline from the treatment plant. Injection pressure would come from the four booster pumps each with a pumping capacity of 1,750 gpm. Figure 13-1 also shows the proposed effluent pipeline alignment.

Groundwater Monitoring Wells

The groundwater monitoring wells in this alternative are the same as those discussed in Alternative 2. Four monitoring wells would be installed in the vicinity of the proposed extraction wells. The depth of these wells is 1,200 feet.

Overall Protection of Human Health and the Environment - The aqueous-phase GAC with reinjection alternative would protect human health and the environment.

Similar to the discussion of Alternative 2, this alternative is a treatment control which utilizes carbon adsorption to capture contaminants from groundwater. Off-site regeneration would serve to destroy contaminants to eliminate potential risks to human health and to the environment. On-site regeneration and other disposal options (landfilling) may be available and could be considered during RD. Off-site options would need to meet applicable standards.

The treated water would meet drinking water standards and state reinjection standards before being returned to the aquifer, thereby increasing protection.

Compliance with ARARs - Alternative 5 does comply with the ARARs identified in the ARARs analysis (Subsection 8.1), including treatment of contaminated water to MCLs and state reinjection standards prior to return to the aquifer. Although off-site activities are not evaluated as ARARs, all applicable requirements for off-site actions would be observed.

Long-Term Effectiveness and Permanence - The aqueous-phase GAC with reinjection alternative would provide long-term effectiveness.

As discussed in the evaluation of Alternative 2, the magnitude of residual risk would be low. The alternative is adequate and suitable to treat the volume of groundwater expected to be encountered within the Muscoy Plume OU. It is a proven and reliable method to treat groundwater that does not result in untreated wastes remaining on site.

Also, as previously discussed, exposure would be limited to human and environmental receptors while carbon is being exchanged. The potential need to replace the alternative or components of the alternative would be low.

Reduction of Toxicity, Mobility, or Volume - This alternative would permanently and irreversibly reduce contaminant toxicity, mobility, and volume through carbon adsorption and regeneration. It is expected to reduce levels of contamination to meet RA objectives. Treatment could not be reversed because contaminants are destroyed off site during regeneration. Upon completion of the remedial action, the only subsurface residual contamination remaining would be that adsorbed to organic carbon contained in the soil at the site.

Short-Term Effectiveness - The aqueous-phase GAC with reinjection alternative would provide short-term effectiveness.

Similar to the discussion of Alternative 2, potential health threats to area residents or the environment are not expected, during construction and implementation. Personnel responsible for spent carbon handling would need to have proper personal protective equipment.

Implementability - The aqueous-phase GAC with reinjection alternative would be implementable. EPA cannot require any water supply agency to accept treated water from this project. The reinjection option is considered a necessary contingency since it can be implemented without dependence on local agencies. If the local agencies participate in the remedy by accepting the treated water and operating some or all of the extraction, treatment, and distribution systems, then the alternatives with municipal end use become more cost effective and easier to implement in the long term.

Similar to the discussion of Alternative 2, the technologies are demonstrated and commercially available, and significant technical unknowns are not expected, during construction and operation.

This alternative is considered to be reliable to operate and maintain during implementation, and additional remedial actions are not expected to be difficult to implement. Monitoring the alternative is considered to be easily accomplished at the extraction wells, GAC unit, and regeneration facility.

Administrative feasibility is similar to that of Alternative 2, with permits for on-site treatment and off-site spent carbon transport being required. The exception to the similarity is approval for treated water disposal using injection wells is required.

Availability of regeneration facilities, necessary equipment, and personnel is high.

Cost - Table 13-11 presents the costs associated with this alternative. The total project costs for Alternative 5 are: capital cost - approximately \$14.0 million, annual O&M cost - approximately \$1.1 million, and total present worth - approximately \$30.8 million.

13.2 COMPARATIVE ANALYSIS OF ALTERNATIVES

The purpose of this comparative analysis is to identify the relative advantages and disadvantages of each alternative. Areas of potential trade-offs, such as one alternative being well-demonstrated, whereas another may be innovative but less proven, are also identified.

Overall Protection of Human Health and the Environment, and Compliance with ARARs are considered threshold criteria and must be satisfied for an alternative to be implemented. The present worth cost is presented so an independent evaluation by the EPA can be based on actual cost and not the ranking system. State and Community Acceptance will be considered after comments are received on the Proposed Plan.

The remaining criteria are evaluated for each alternative. Each alternative is assigned a ranking number from one to five. A one represents the alternative meets the criteria in least preferred manner, and five represents the alternative meets the criteria in most preferred manner. The numerical total of the criteria scores (or Total Score) is used to determine the relative ranking of alternatives.

Table 13-12 summarizes the ranking results of this comparison.

13.2.1 Overall Protection of Human Health and the Environment

All of the alternatives except Alternative 1, No Action, are protective of human health and the environment. They meet the RA objectives to prevent ingestion of TCE, PCE, and cis-1,2-DCE above the MCLs. Also, each of these alternatives would restore the quality of the aquifer by reducing contaminant levels to below the MCLs. The No Action alternative does not reduce risk of exposure or restore quality of the aquifer.

13.2.2 Compliance with ARARs

Although this action is designed for plume containment and not aquifer restoration, an interim measure waiver is not invoked for any of the ARARs presented. The No Action alternative does not provide for plume containment or remove VOC contaminants from the aquifer.

Aqueous GAC Treatment and Air Stripping with BACT Off-Gas Treatment (i.e., Alternatives 2,3, and 5) attain their respective chemical-, location-, and action-specific ARARs.

Table 13-11

ESTIMATED COST - ALTERNATIVE 5: AQUEOUS GAC WITH REINJECTION

Description	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Total	Total Cost Material	Total Cost Labor	Total Cost Total
CAPITAL COST								
Groundwater Extraction								
Extraction Wells	4,000	lf	$70	$180	$250	$280,000	$720,000	$1,000,000
Extraction Pumps	4	ea	20,000	4,000	24,000	80,000	16,000	96,000
Pipeline	10,080	lf	50	58	108	504,000	584,640	1,088,640
Subtotal								$2,184,640
Treatment Facilities								
Start-up Filters	2	ea	$33,000	$5,000	$38,000	$66,000	$10,000	$76,000
GAC Units	10	pairs	160,000	1,600	161,600	1,600,000	16,000	1,616,000
Effluent Tank	1	ea	60,000	30,000	90,000	60,000	30,000	90,000
Backwash Tank	1	ea	27,000	8,000	35,000	27,000	8,000	35,000
Backwash Pump	1	ea	5,000	1,000	6,000	5,000	1,000	6,000
pH Control System	1	ls	10,000	7,000	17,000	10,000	7,000	17,000
Building	480	sf	50	20	70	24,000	9,600	33,600
Structural	1	ls			80,000			80,000
Site Work & Yard Piping		ls			160,000			160,000
Site Electrical		ls			80,000			80,000
Subtotal								$2,193,600

Table 13-11 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 5: AQUEOUS GAC WITH REINJECTION

Description	Quantity	Unit	Unit Cost Material	Unit Cost Labor	Unit Cost Total	Total Cost Material	Total Cost Labor	Total Cost Total
CAPITAL COST (Cont'd.)								
End Use								
Booster Pumps	4	ea	$10,000	$2,000	$12,000	$40,000	$8,000	$48,000
Injection Well	6,800	lf	70	180	250	476,000	1,224,000	1,700,000
Pipeline	20,200	lf	42	48	90	848,400	969,600	1,818,000
Pipeline (in Infl. Pipe Trench)	10,000	lf	20	12	32	200,000	120,000	320,000
Subtotal								$3,886,000
Groundwater Monitoring Wells								
Wells	4800	lf	$50	$105	$155	$240,000	$504,000	$744,000
Subtotal								$744,000
TOTAL CONSTRUCTION COST								$9,008,240
Contractor OH & P		15%						$1,351,236
Engineering & Const. Management		15%						1,351,236
Administration		5%						450,412
Contingency		20%						1,801,648
TOTAL CAPITAL COST								$13,962,772

Table 13-11 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 5: AQUEOUS GAC WITH REINJECTION

Description	Utilities	Materials	Labor	Total
ANNUAL O&M COST				
Groundwater Extraction				
Extraction Wells	$238,270	$20,000	$16,000	$274,270
Pipeline	0	10,000	5,000	15,000
Subtotal				$289,270
Treatment Facilities				
GAC Units	$0	$550,000	$11,000	$561,000
Backwash Pumps	50	500	500	1,050
pH System	650	2,000	7,200	9,850
Subtotal				$571,900
End Use				
Booster Pumps	$80,600	$12,000	$8,000	$100,600
Injection Well	0	5,000	31,170	$36,170
Pipeline	0	20,000	10,000	30,000
Subtotal				$166,770
Groundwater Monitoring Wells				
Monitoring Wells	$0	$33,600	$35,200	$68,800
Subtotal				$68,800

Table 13-11 (Cont'd.)

ESTIMATED COST - ALTERNATIVE 5: AQUEOUS GAC WITH REINJECTION

Description	Utilities	Materials	Labor	Total
TOTAL ANNUAL O&M COST				$1,096,740
PRESENT WORTH OF ANNUAL O&M COST				$16,859,582
TOTAL PRESENT WORTH				$30,822,354

Table 13-12

ALTERNATIVE COMPARATIVE ANALYSIS
Muscoy Plume OU

Remedial Alternative	Overall Protection of Human Health and the Environment	Compliance with ARARs	Ranking Score					Total Score	Relative Ranking
			Long-Term Effectiveness and Permanence	Reduction of Toxicity, Mobility or Volume	Short-Term Effectiveness	Implementability	Cost		
Alternative 1: No Action	No	No	1	1	5	5	5	18	--
Alternative 2: Aqueous Phase GAC	Yes	Yes	4	4	4	4	3	19	1
Alternative 3: Air Stripping with BACT Off-Gas Treatment	Yes	Yes	4	3	4	3	4	18	2
Alternative 4: Advanced Oxidation	Yes	Yes	4	5	3	2	1	16	4
Alternative 5: Aqueous Phase GAC with Injection Well	Yes	Yes	4	4	4	4	2	18	2

Notes:
a. State and community acceptance criteria are not compared.
b. Yes = Meets the criteria.
c. No = Does not meet the criteria.
d. Alternative ranking score under each criteria = a score on the scale of 1 to 5 is used. Score 1 represents the alternative meets the criteria in least preferred manner, and score 5 represents the alternative meets the criteria in most preferred manner.

Total score - is obtained by summing up the ranking score for all the criteria under the alternative. Alternative with the highest total score comparatively best meets the criteria. Alternative with lowest total score comparatively least meets the criteria.

Relative Ranking - Alternative with highest total score is the most preferred alternative, and given a relative ranking of 1. Alternative with lowest total score is the least preferred alternative, and given a relative ranking of 4. Alternative 1 is not given a relative ranking because it does not meet first two criteria.

The Advanced Oxidation treatment process (Alternative 4) is an innovative technology not proven with the anticipated flow rate for this action of 7,000 gpm. As discussed in the previous section, advanced oxidation treatment would require both bench- and pilot-scale treatability studies to determine the effectiveness of this alternative. ARARs attainment for the Advanced Oxidation alternative is contingent on the results of these studies. The adequacy and reliability of advanced oxidation is undemonstrated for municipal use since there is a lack of long-term operational data. This may result in the requirement of a demonstrated secondary treatment process to assure effluent water quality.

13.2.3 Long-Term Effectiveness and Permanence

All treatment alternatives were given a ranking of 4 because they all provide the same level of residual risk and reliability of treatment after the RA is complete. The No Action alternative was given a ranking of 1 because it does not provide long-term effectiveness.

13.2.4 Reduction of Toxicity, Mobility, or Volume

All of the alternatives except Alternative 1, No Action, provide a high degree of reduction in toxicity, mobility, or volume. Alternative 4, Advanced Oxidation with Municipal End Use, was given the highest ranking of 5 because this treatment process is destructive of contaminants. Alternative 2, Aqueous-Phase GAC with Municipal End Use, and Alternative 5, Aqueous-Phase GAC with Reinjection, were given a ranking of 4, because carbon regeneration is required. Alternative 3, Air Stripping with BACT (or Vapor-Phase GAC Treatment) and Municipal End Use, was given a slightly lower ranking of 3 because low levels of contaminants will be emitted from the off-gas treatment system. The No Action alternative was given a ranking of 1 because it does not reduce toxicity, mobility, or volume.

13.2.5 Short-Term Effectiveness

Alternative 1, No Action, was given the highest ranking of 5 because it has the smallest risk of exposure of workers to contamination during implementation. The alternatives that use some form of GAC, Alternatives 2, 3, and 5, were given a ranking of 4 because of the slight risk of exposure when spent carbon is transported to a regeneration and disposal facility. Workers may also be exposed during this process. Alternative 4, Advanced Oxidation, was given a ranking of 3 because of the risk of exposure to oxidants during operation of the treatment plant.

13.2.6 Implementability

Alternative 1, No Action, was given a ranking of 5 because it is easily implemented both technically and administratively. Services and equipment are readily available for monitoring.

Alternatives 2 and 5 which use aqueous GAC were given a slightly lower ranking of 4 because more coordination with agencies will be required to construct the treatment facilities. Air stripping with BACT (or vapor phase GAC) off-gas treatment, Alternative 3, was given a 3 because air discharge permits are required. Services and equipment are readily available for all GAC treatment alternatives.

Alternative 4, Advanced Oxidation, was given a ranking of 2 because the process has not been widely used for VOC treatment. Because advanced oxidation has been used in the waste-water industry equipment and services can be easily obtained.

Table 13-14

SENSITIVITY ANALYSIS: VARIATION OF ANNUAL CARBON USAGE - ALTERNATIVE 2

Annual Carbon Usage (x 1000 lb)		Capital Cost	Annual O&M	Present Worth	Total Present Worth
Low	365	$8,066,572	$979,710	$15,060,544	$23,127,116
Design	550	$8,066,572	$1,168,410	$17,961,326	$26,027,898
High	730	$8,066,572	$1,352,010	$20,783,708	$28,850,280

Notes: Present Worth column shows the present worth of annual O&M cost calculated for a duration of 30 years with a discount rate of 5%.

Total Present Worth column is obtained by adding Capital Cost column and Present Worth column.

The following factors are considered for the sensitivity analysis: annual aqueous-phase carbon usage for Alternatives 2 and 5, air/water ratio for Alternative 3, and ozone/peroxide dosage rate for Alternative 4. These factors, as seen in the Estimated Cost tables presented throughout Subsection 13.1, can significantly affect the total present worth of the alternatives. Influent water concentration is another factor that can affect the present worth significantly. Details of the cost sensitivity analysis for each alternative are presented below.

Factors involved (number of monitoring wells, frequency of sampling and number of wells to be installed) in the cost estimate for Alternative 1 represent a fairly definite set of assumptions. Thus, a sensitivity analysis for this alternative is not necessary.

The sensitivity analysis for Alternative 2 was performed by varying the annual aqueous-phase carbon usage. Table 13-14 shows the results of the sensitivity analysis for Alternative 2. Three different values for annual carbon usage (Low, Design, and High) were used for the sensitivity analysis. The carbon usage design value, as presented in Table 13-14, was determined using the isotherm calculation and vendor's quotation for influent water concentration of 30 $\mu g/\ell$ PCE, 10 $\mu g/\ell$ TCE, and 10 $\mu g/\ell$ cis-1,2-DCE. Low and high values include the range of carbon usage proposed by various vendors. The sensitivity analysis shown in Table 13-14 indicates that the present worth for Alternative 2 can decrease or increase by approximately $2.9 million when the annual carbon usage is varied from the low to high value. Utilization of the existing 19th Street treatment facility could change this economic analysis.

Air/water ratio required to strip organics from the water was used for the sensitivity analysis for Alternative 3. Typically, change in the air/water ratio may affect the capital and O&M costs of blowers and air heaters and the capital cost of vapor-phase GAC. In the sensitivity analysis presented here, it was assumed that the change in air/water ratio only affects the capital and O&M costs of the blowers. Therefore, this sensitivity analysis represents a limited scope. Table 13-15 shows the results of the sensitivity analysis for this alternative. The three different values for air/water ratio (Low = 20, Design = 25, and High = 30) were based on the vendor's quotation. The sensitivity analysis indicates that the present worth for Alternative 3 can decrease by approximately $0.1 million or increase by approximately $0.2 million when the air/water ratio is varied from the low to high.

Ozone/peroxide dosage rate was used for the sensitivity analysis for Alternative 4. Table 13-16 shows the results of sensitivity analysis for the project. The three different values for ozone/peroxide ratio (Low = 7:3, Design = 10.5:4.5, and High = 14:6) were based on the vendor's quotation. The sensitivity analysis indicates that the present worth for Alternative 4 can decrease by approximately $2.9 million or increase by approximately $3.9 million depending on the ozone/peroxide ratio.

Sensitivity analysis for Alternative 5 was performed by varying the annual aqueous carbon usage. Table 13-17 shows the results of sensitivity analysis for this alternative. As discussed in the sensitivity analysis for Alternative 2, three different values for annual carbon usage were used for the sensitivity analysis. The sensitivity analysis indicates that the present worth for Alternative 5 can decrease or increase by approximately $2.9 million when the annual carbon usage is varied to the low or high value.

Figure 13-8 shows the results of the sensitivity analysis for Alternatives 2 through 5. The total present worth of the Alternative 4 is the most sensitive, while the Alternative 3 represents a limited scope whereas the sensitivity analysis for the remaining alternatives represents a comprehensive analysis.

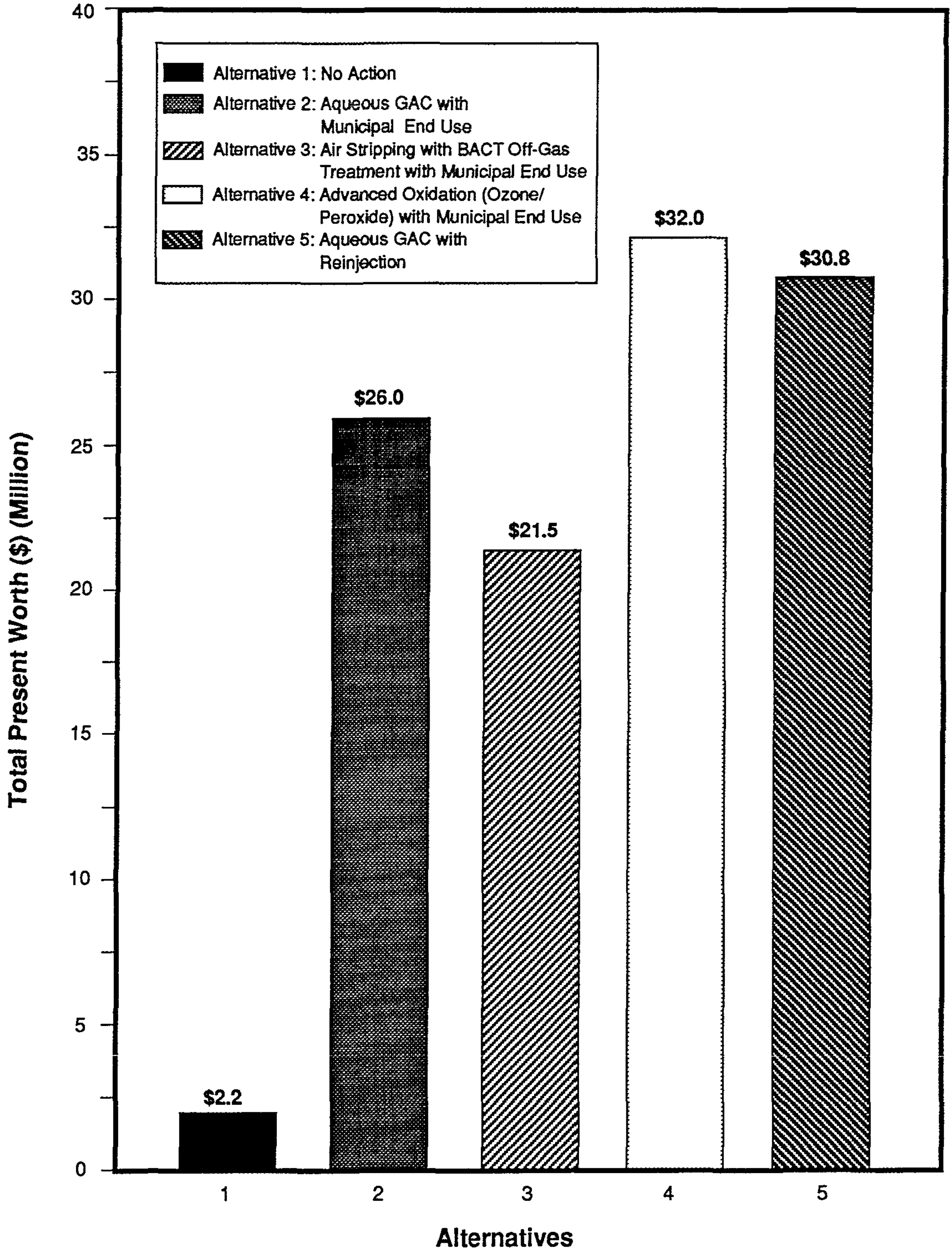


Figure 13-7
Comparison of Present-Worth of Alternatives
Muscoy Plume OU RI/FS Report
Newmark Groundwater Contamination Superfund Site

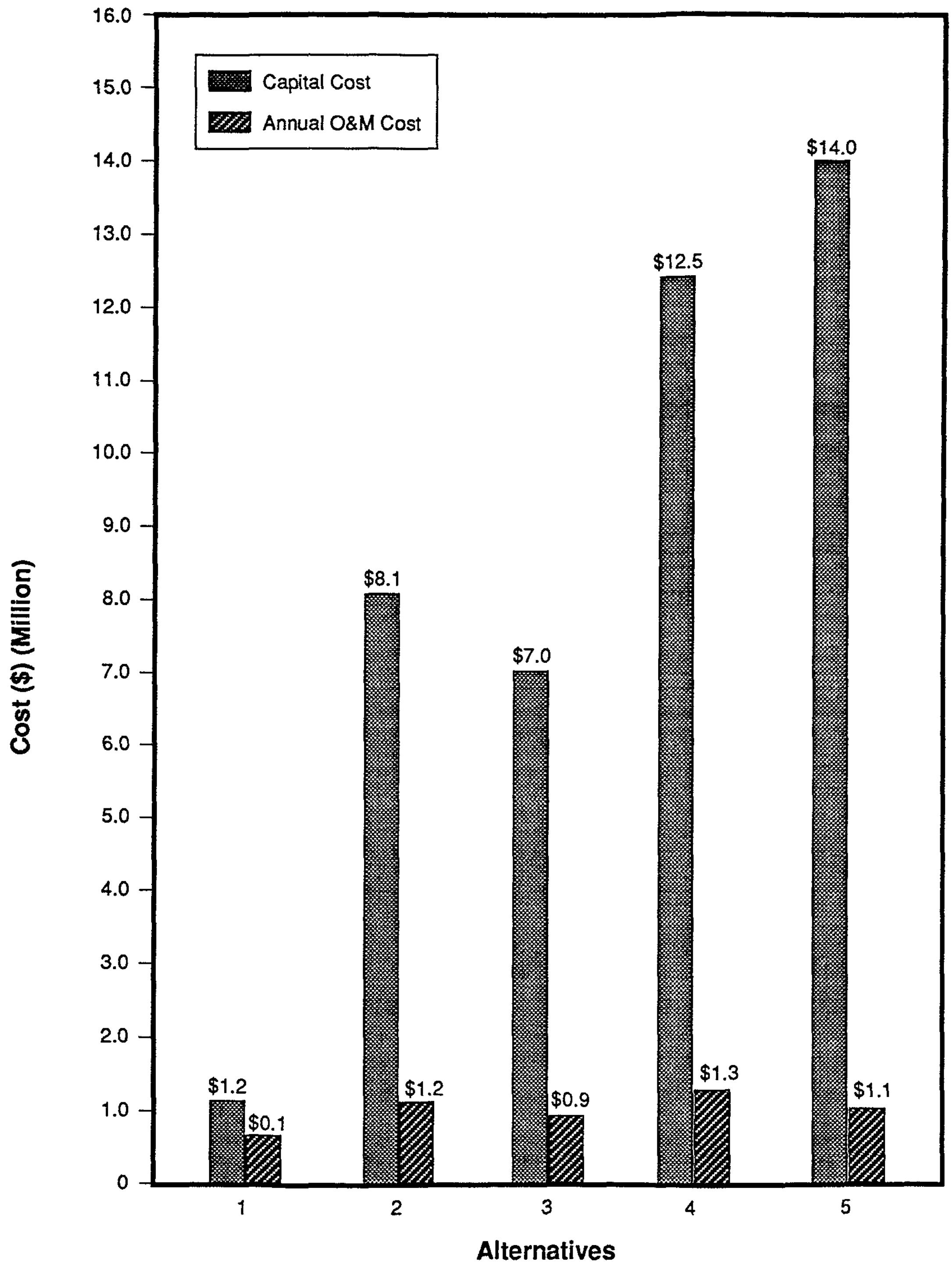


Figure 13-6

Comparison of Capital and Annual O&M Costs for Alternatives

Muscoy Plume OU RI/FS Report

Newmark Groundwater Contamination Superfund Site